1488-92
Report

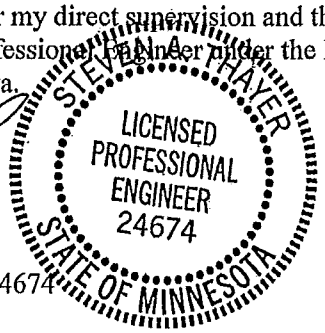
A Geotechnical Evaluation Report

Proposed Monticello Business Center
Chelsea Road
Monticello, Minnesota

Prepared for

WSB & Associates, Inc.

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.



Steve A. Thayer, PE
Senior Engineer
Registration Number: 24674
August 7, 2006

Project SC-05-00534B

Braun Intertec Corporation

BRAUN
INTERTEC

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August 7, 2006

Our Project SC-05-00534B

Mr. Jason Abell
WSB & Associates, Inc.
701 Xenia Avenue South, Suite 300
Minneapolis, MN 55416

Re: Geotechnical Evaluation
Proposed Monticello Business Center
Chelsea Road
Monticello, Minnesota

Dear Mr. Abell:

We have completed the geotechnical evaluation you requested and authorized on June 26, 2006. The purpose of our evaluation was to assist WSB & Associates, Inc., in preparing plans and specifications for construction of the proposed development.

Summary of Results

We completed 15 soil borings and 10 test pits on the project site. The soil borings generally encountered 0 to 2 1/2 feet of topsoil underlain by poorly graded sand. Borings 7, 8 and 9 encountered 5 to 12 feet of fill underlain by poorly graded sand. Penetration resistances indicated the poorly graded sands were generally loose to medium dense. Groundwater was generally encountered in the borings at elevations ranging from 925 to 930.

The test pits indicated the onsite stockpiles generally consist of topsoil stripped from other areas of the site.

Summary of Recommendations

Mass Grading. We recommend fill, topsoils and black or organic soils be removed from beneath the proposed building pads, slabs and pavements. The pad, slab and pavement areas should then be cut, backfilled and filled up to design grades.

We recommend backfill and fill for the residences be moisture-conditioned to a moisture content over optimum and compacted to a minimum of 90 percent of its maximum dry density determined in accordance with ASTM Method of Test D 698 (standard Proctor). Backfill and fill placed in the building pads and beneath slabs should be compacted to a minimum of 95 percent. Backfill and fill under pavements should be placed and compacted in accordance with Minnesota Department of Transportation Specification 2105.

Building Pads. After site grading is complete, it is our opinion the soils will be suitable for support of buildings constructed on spread footing foundations. Soil bearing capacities appear to range from 2,000 to over 4,000 pounds per square foot (psf). Properly compacted backfill and fill will be able to support footing bearing pressures up to 3,000 psf.

Utilities. The soils encountered at invert depths in the borings appear suitable for support of the proposed utilities. Dewatering will likely be necessary for installation of utilities on low areas of the site.

Roadways. We recommend removing topsoil and existing fill from the roadway alignments and cutting, backfilling and filling to desired grades. We anticipate the subgrade soils will generally consist of poorly graded sand. We recommend the pavements be designed for an R value of 70.

General

Please refer to the attached report for a more detailed summary of our analyses and recommendations. If we can provide additional assistance, or observation and testing services during construction, please call Steve Thayer at (320) 253-9940.

Sincerely,

BRAUN INTERTEC CORPORATION

Steve A. Thayer, PE
Senior Engineer

Steven P. Nagle, PE
Principal Engineer

Attachment:
Geotechnical Evaluation Report

00534B

Table of Contents

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A. Introduction

A.1. Project

The City of Monticello is planning to conduct mass grading to prepare the Monticello Business Center for new commercial buildings, utility installation and roadway construction. The project is located on the south side of Chelsea Road in Monticello, Minnesota.

A.2. Purpose of This Evaluation

The purpose of this geotechnical evaluation was to assist WSB & Associates, Inc. (WSB), in designing building pads, utilities and pavements, and in preparing plans and specifications for construction of the proposed development.

A.3. Scope

Mr. Jason Abell of WSB authorized soil borings, test pits and a geotechnical evaluation report.

Our scope of services was limited to:

- coordinating the locating of underground utilities near the boring locations,
- conducting six penetration test borings to a depth of 15 feet, seven penetration test borings to a depth of 20 feet and two penetration test borings to a depth of 25 feet,
- conducting test pits in the six stockpiles on the site.
- classifying the samples and preparing boring logs,
- analyzing the results of the field tests,
- formulating preliminary recommendations for mass grading, utilities and pavements,
- discussing the results and preliminary recommendations with WSB, and
- submitting a geotechnical evaluation report containing logs of the borings, analyses of the field tests, and recommendations for mass grading, utility installations, and roadway subgrade preparation.

A.4. Documents Provided

Mr. Abell provided us with a Proposed Boring Location plan prepared by WSB and dated June 26, 2006. Mr. Abell also provided us with a grading plan. Neither the preparer nor the date prepared were indicated on our copy.

A.5. Locations and Elevations

The borings were completed at the locations staked in the field by WSB. The planned locations of Borings 4 and 13 were not accessible to our drill rig because of overhead power lines and a steep slope,

respectively. We offset these locations and designated our drilled location with the suffix "A". The offset distances are given in the "Location" box on the Log of Boring Sheet.

Ground surface elevations at the borings were provided by WSB.

B. Results

B.1. Logs

Log of Boring sheets indicating the depths and identifications of the various soil strata, penetration resistances and groundwater observations are included in the Appendix. Fence Diagrams summarizing the borings follow this page. The strata changes were inferred from the changes in the penetration test samples and auger cuttings. It should be noted that the depths shown as changes between the strata are only approximate. The changes are likely transitions and the depths of the changes vary between the borings.

Geologic origins presented for each stratum on the Log of Boring sheets are based on the soil types, blows per foot, and available common knowledge of the depositional history of the sites. Because of the complex glacial and post-glacial depositional environments, geologic origins are frequently difficult to ascertain. A detailed investigation of the geologic history of the site was not performed.

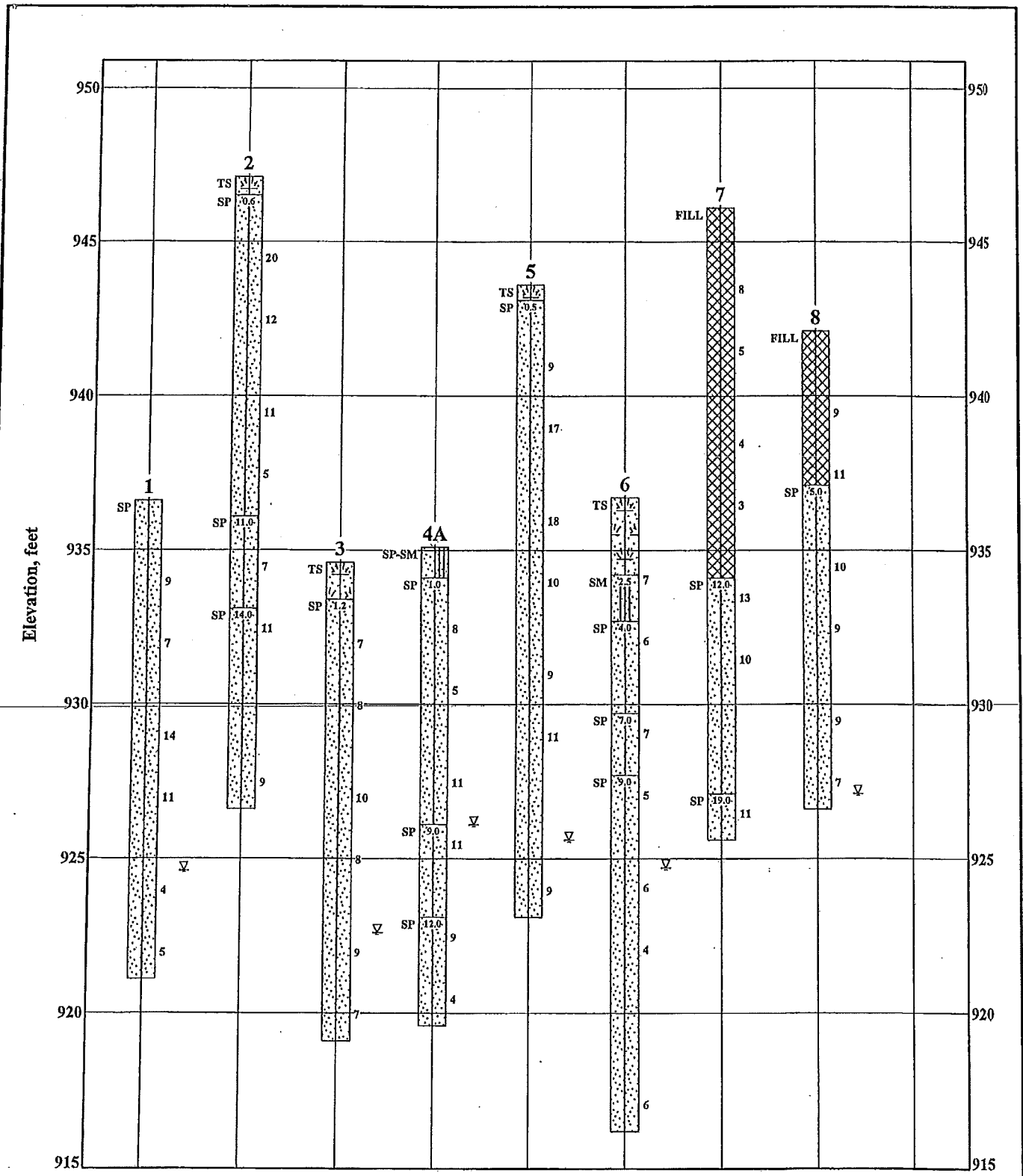
B.2. Site Conditions

The site was previously used as a gravel pit. It appears most of the mining occurred on the south half of the site. The gravel pit area was not covered with topsoil. The rest of the site was covered with weeds and slightly rolling terrain.

B.3. Soils

B.3.a. Borings. We completed 15 penetration test borings for the proposed project. Borings 2, 3, 5, 6, 10, 11, 12 and 15 encountered 1/2 to 2 1/2 feet of topsoil underlain by poorly graded sand. Borings 1, 4, 13A and 14 encountered poorly graded sand (topsoil was not encountered). Borings 7, 8 and 9 encountered 5 to 12 feet of fill underlain by poorly graded sand.

Penetration resistances in the poorly graded sand ranged from 1 to 22 blows per foot (BPF), indicating it ranged from very loose to medium dense. In general, the sand was loose to medium dense.



Fence Diagram: Point to Point

(Horizontal distance not to scale)

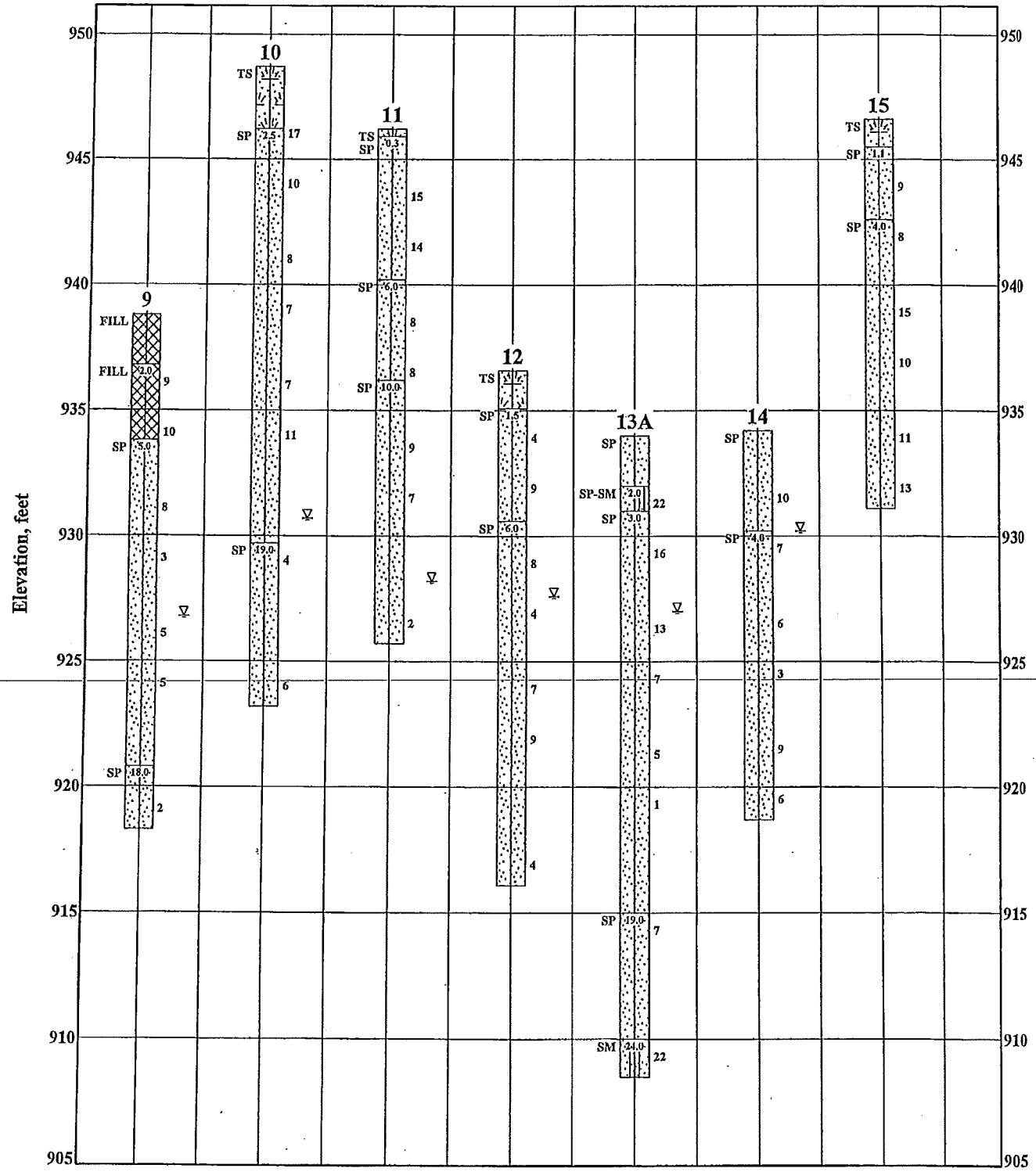
Braun Project SC-05-00534B
Geotechnical Evaluation
Site Grading
Monticello Business Park
Monticello, Minnesota

BRAUN INTERTEC

Figure 1

ELEVATION SCALE 00534B.GPJ BRAUN.GDT 8/7/06 14:24

SC-05-00534B



Fence Diagram: Point to Point

(Horizontal distance not to scale)

Braun Project SC-05-00534B
Geotechnical Evaluation
Site Grading
Monticello Business Park
Monticello, Minnesota

BRAUN SM INTERTEC

Figure 2

ELEVATION SCALE 00534B.GPJ BRAUN.GDT 8/7/06 14:24

SC-05-00534B

B.3.b. Test Pits. We completed 10 test pits on the soil stockpiles on the site. The soils observed in the test pits are summarized in the table below. The approximate locations are shown on the sketch in the appendix of this report.

Location	Stockpile	Location Description	Soils Encountered*
TP-1	5	SW corner, about 1/2 way up pile	SPSM, brown, with layers of SM topsoil over natural SP
TP-2	5	NE corner, about 1/2 way up pile	9' of SM topsoil over natural SP
TP-3	5	SE corner, about 1/2 way up pile	9' of SM topsoil over natural SP
TP-4	4	Near center of pile	4' of SM topsoil over natural SP
TP-5	6	Top of pile, north half	8' of SM topsoil, 2' of SPSM, brown over natural SP
TP-6	6	Top of pile, south half	7' of SM topsoil over natural SP
TP-7	6	SW corner, near bottom of pile	1/2' of SM topsoil over natural SP
TP-8	3	South side, 1/2 way up pile	10' of SM topsoil over natural SP
TP-9	3	South side, edge of pile	1' of SM topsoil over natural SP
TP-10	1	Middle of pile	5' of SP, brown sand over 2' of SM topsoil over natural SP
TP-11	2	Middle of pile	4' of SM topsoil over natural SP

*SPSM – Poorly Graded Sand with Silt; SP – Poorly Graded Sand; SM – Silty Sand

In general, it appears the stockpiles were created with tospsoil and "B" horizon topsoil (dark brown layer below the black layer) from mining areas of the site. An exception is Stockpile 1, which was mostly sand piled over the original topsoil layer.

B.4. Groundwater

Groundwater was generally observed in the borings at depths ranging from 4 to 19 feet in the borings. Based on these observations, it appears the groundwater surface ranges from elevation 923 to 930. The groundwater surface appears to slope generally down to the north.

Seasonal and annual fluctuations of the groundwater levels should be anticipated. Elevated levels should be anticipated following spring thaw and wet weather.

C. Analyses and Recommendations

C.1. Proposed Construction

The proposed development will include the installation of new utilities (storm sewer, water main and sanitary sewer), construction of new streets, and construction of commercial building pads.

We have assumed storm sewer invert depths will range from 3 to 8 feet. Water mains generally have about 8 feet of cover. Sanitary sewer invert depths generally range from 10 to 20 feet. Based on the grading plan, it appears cuts/fills will generally not exceed 10 feet.

We have assumed the street and utility construction will be performed in general accordance with the Minnesota Department of Transportation's (Mn/DOT's) *Standard Specifications for Construction.*

If the proposed depths differ from these values or if our understanding of the proposed construction is not correct, we should be informed. Additional analyses and revised recommendations may be necessary.

C.2. Discussion

Based on the borings, it appears the natural sand soils are suitable for building pad and roadway construction. The soils at the anticipated utility invert depths appear suitable for support of the proposed utilities.

The test pits in the stockpiles generally encountered topsoil. It is our opinion these soils are not suitable for use in building pads and roadway construction.

C.3. Site Grading

C.3.a. General. The preliminary grading plan indicates most of the area outside of the gravel pit will be within 3 feet of existing grades. The area within the gravel pit will have fills ranging from about 4 to 8 feet. A pond will be constructed on the west side of the site, which will require a cut of about 14 feet. We anticipate conventional excavation equipment such as scrapers, front-end loaders, backhoes, motor graders and bulldozers can be used for moving the earth. Clearing, grubbing, stripping, backfilling and filling should be oversized and carefully controlled. The limits of the building pads should be carefully documented.

C.3.b. Clearing, Grubbing and Stripping. We recommend clearing and grubbing the proposed building, slab and pavement areas. Vegetation, topsoils and black or organic fill soils should be removed from the proposed building, slab and pavement areas. The borings indicate stripping depths will generally range from 1/2 to 2 1/2 feet. Deeper excavation will likely be necessary in the parts of the site where topsoil has been stockpiled or used to raise grades.

Stripping should extend at least one foot outside the proposed building footprints, slabs and pavements for each foot of fill below the proposed perimeter footings, slabs and pavements (1:1 oversizing).

C.3.c. Suitable Backfill and Fill Material. The existing poorly graded sand soils may be used as backfill and fill. We do not recommend reusing any of the topsoil, black or dark brown existing fill soils as backfill or fill within the building pads, slabs or pavement areas.

C.3.d. Moisture Conditioning. For the building pads and exterior slabs, we recommend poorly graded sand soils be placed at moisture contents within 3 percentage points of optimum. Backfill and fill under pavements should be moisture-conditioned in accordance with Mn/DOT Specification 2105.

C.3.e. Compaction. Backfill and fill should be compacted to a minimum of 90 percent of its maximum dry density determined in accordance with ASTM Method of Test D 698 (standard Proctor). Backfill and fill in building pads and beneath exterior slabs should be compacted to a minimum of 95 percent of its maximum dry density. Backfill and fill under pavements should be placed and compacted in accordance with Mn/DOT Specification 2105, Specified Density Method.

C.3.f. Building Foundation Design. If backfill and fill has been placed as recommended above, it is our opinion footings bearing on backfill and fill may be designed for net allowable bearing pressures up to 3,000 pounds per square foot (psf). The borings indicate footings bearing on natural soils may be designed for net allowable bearing pressures of 2,000 to over 4,000 psf, depending upon the locations and depths of the footings.

C.4. Utilities

C.4.a. Excavation. Based on the borings, we anticipate the trenches can be excavated with a backhoe. Soils will likely consist of sand, Type C soils under Department of Labor Occupational Safety and Health Administration (OSHA) guidelines.

C.4.b. Dewatering. Some dewatering of trenches will likely be required. Where the trench bottoms extend only 1 to 2 feet below the groundwater level, we anticipate dewatering can be accomplished by pumping water from sumps placed in the low points of the trenches. Where the trenches or excavations extend more than 2 feet into waterbearing sands, well points or deep wells will likely be necessary.

C.4.c. Materials. Poorly graded sand soils are generally not corrosive to metal conduits. We recommend bedding conduits with site or imported sands (SP or SP-SM) with a maximum particle size of 3/4 inch to reduce the potential for corrosion.

C.4.d. Backfilling and Compaction. We recommend that bedding materials be thoroughly compacted around the pipes. We recommend backfill soils be placed at moisture contents within 3 percentage points of optimum.

Backfill should be compacted to a minimum of 90 percent of its maximum dry density determined in accordance with ASTM Method of Test D 698 (standard Proctor). Backfill beneath building pads, exterior slabs and pavements should be compacted to a minimum of 95 percent of its maximum dry density. The upper 3 feet of pavement subgrades should be compacted to a minimum of 100 percent.

C.5. Pavements

C.5.a. Subgrade Preparation. We recommend existing fill, topsoil, vegetation and organic materials be removed from below proposed pavements. After stripping, we recommend that the upper 1/2 foot of the underlying soil subgrade be scarified, moisture-conditioned to a moisture content near optimum, and compacted to a minimum of 95 percent of its standard Proctor maximum dry density. If there are areas that cannot be adequately compacted or are very soft, we recommend the unstable or soft materials be removed and be replaced by compactable backfill.

Where fill is required, we anticipate on-site soils from cut areas can be used. Fill under pavements should be placed in accordance with Mn/DOT Specification 2105, Specified Density Method.

C.5.b. Anticipated Subgrades. After preparation, we anticipate the subgrades will consist of poorly graded sand soils. Laboratory tests to determine the resistance (R) values of the subgrade soils were not included in our scope of services. Table 5-3.2(a) of the Minnesota Department of Transportation (Mn/DOT) *Geotechnical and Pavement Design Manual* indicates sand soils generally have an R value of 70. We recommend pavements be designed for a subgrade with an R value of 70.

C.5.c. Materials and Compaction. The aggregate base should meet the requirements of Mn/DOT Specification 3138 for Class 5 or 6. We recommend the bituminous meet the requirements of Specification 2360. We recommend Portland cement concrete meet the requirements of Specification 2301.

We recommend the crushed gravel base be compacted to a minimum of 100 percent of their respective standard Proctor maximum dry densities. We recommend the bituminous surface courses be compacted to a minimum of 92 percent of its theoretical maximum density.

D. Construction

D.1. Excavation and Dewatering

Excavation and dewatering were discussed in Sections C.3, C.4 and C.5 above.

D.2. Observations

We recommend all excavation subgrades be observed by a geotechnical engineer to evaluate if the subgrade soils are similar to those encountered by the borings and adequate to support the proposed construction. Oversizing of building pad excavations should be checked. Limits and locations of the building pads should be documented. These observations should be conducted prior to placing backfill or fill.

D.3. Testing

We recommend density testing of the compacted pavement subgrade, embankments and gravel base course. Compaction of fill placed in building pads and beneath exterior slabs should be tested. Samples of proposed backfill and fill materials should be submitted to a testing laboratory at least three days prior to placement for evaluation of their suitability and determination of their optimum moisture contents and maximum dry densities.

D.4. Cold Weather

If site grading is anticipated during cold weather, we recommend good winter construction practices be observed. All snow and ice should be removed from cut and fill areas prior to grading. Frozen soils should not be used as backfill and fill.

Grading should not be performed during periods when the grading material freezes while being placed and compacted, nor should any grading material be placed on soil that is frozen to a depth greater than 4 inches. When the foundation soils are frozen to a depth exceeding 4 inches, at a time when weather conditions are such that embankment construction could be continued without the material freezing as it is being placed and compacted, the contractor may be permitted to excavate the frozen foundation soil and proceed with grading for so long as the weather will permit with the understanding that the additional costs involved shall be borne by the contractor. The frozen soil should be pulverized or wasted and replaced with other suitable soil, as may be necessary to construct the subgrades as specified.

E. Procedures

E.1. Drilling and Sampling

We performed the penetration test borings on July 10 and 11, 2006, with a truck-mounted drill and auger equipped with 3 1/4-inch inside diameter hollow-stem auger. Sampling for the borings was conducted in general accordance with ASTM D 1586, "Penetration Test and Split-Barrel Sampling of Soils."

We advanced the boreholes with the hollow-stem auger to the desired test depths. A 140-pound hammer falling 30 inches was then used to drive the standard 2-inch split-barrel sampler a total penetration of 1 1/2 feet below the tip of the hollow-stem auger. The blows for the last foot of penetration were recorded and are an index of soil strength characteristics. Samples were taken at 2- to 3-foot vertical intervals to a depth of 15 feet and then at 5-foot vertical intervals to the termination depths of the borings. A portion of each sample was placed in a glass jar.

E.2. Test Pits

We observed test pit excavations on July 6, 2006. The test pits were dug with a rubber-tired tractor backhoe. The backhoe was operated by the City of Monticello. Mr. Steve Thayer of Braun Intertec chose the locations of the test pits. The soils were classified by observing the excavated material and sidewalls of the excavation. After completion, the test pits were backfilled.

E.3. Soil Classification

The drill crew chief visually and manually classified the soils encountered in the borings in accordance with ASTM D 2488, "Description and Identification of Soils (Visual-Manual Procedures)." A summary of the ASTM classification system is included in the Appendix. All samples were then returned to our laboratory for review of the field classifications by a geotechnical engineer. Samples will remain in our St. Cloud office for a period of 60 days to be available for examination. These samples will then be discarded unless we are notified in writing to retain them longer.

E.4. Groundwater Observations

The depths at which groundwater was observed while drilling were recorded. The depths at which groundwater was observed after taking the last sample in each hole were recorded. Immediately after withdrawal of the auger, the holes were again probed and the depths to water or cave-ins were noted. The borings were then immediately backfilled.

F. General Recommendations

F.1. Basis of Recommendations

The analyses and recommendations submitted in this report are based upon the data obtained from the soil borings performed at the locations indicated on the attached sketch. Often, variations occur between these borings, the nature and extent of which do not become evident until additional exploration or construction is conducted. A re-evaluation of the recommendations in this report should be made after performing on-site observations prior to or during construction to note the characteristics of any

variations. The variations may result in additional foundation costs, and it is suggested that a contingency be provided for this purpose.

We recommend that we be retained to perform the observation and testing program for the site preparation phases of this project. This will allow correlation of the soil conditions encountered during construction to the soil borings, and will provide continuity of professional responsibility.

F.2. Review of Design

This report is based on the design and proposed grades of the proposed residences, utilities and pavements assumed for preparation of this report. We recommend that we be retained to review the geotechnical aspects of the final designs, grades and specifications. With the review, we will evaluate whether any changes in design have affected the validity of the recommendations, and whether our recommendations have been correctly interpreted and implemented in the design and specifications.

F.3. Groundwater Fluctuations

We made water level observations in the borings at the times and under the conditions stated on the boring logs. These data were interpreted in the text of this report. The period of observation was relatively short, and fluctuations in the groundwater levels may occur due to rainfall, flooding, irrigation, spring thaw, drainage, and other seasonal and annual factors not evident at the time the observations were made. Design drawings and specifications and construction planning should recognize the possibility of fluctuations.

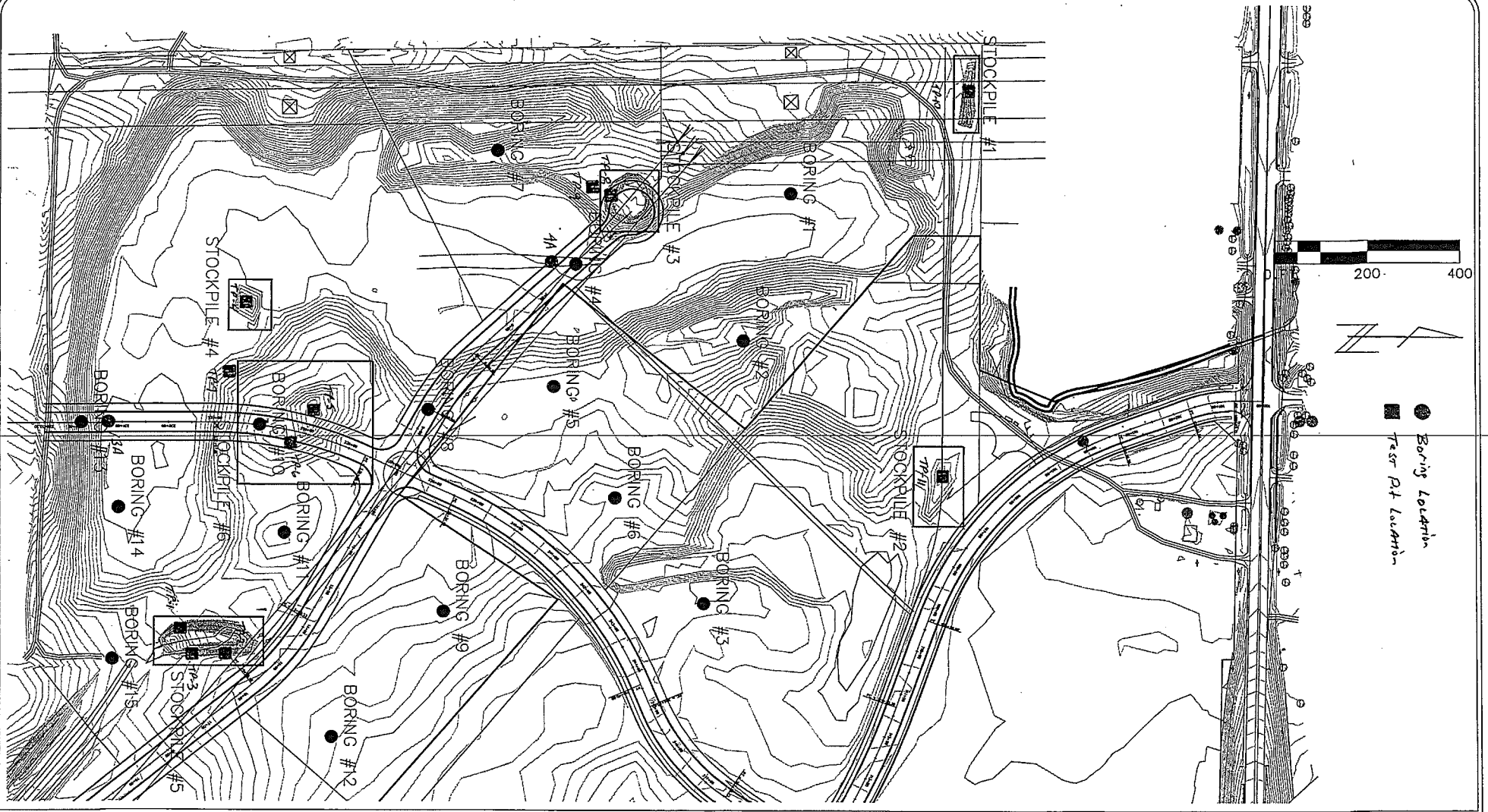
F.4. Use of Report

This report is for the exclusive use of WSB and the City of Monticello to use to design the proposed grading, pavements and utilities, and prepare construction documents. In the absence of our written approval, we make no representation and assume no responsibility to other parties regarding this report. The data, analyses and recommendations may not be appropriate for other structures or purposes. We recommend that parties contemplating other structures or purposes contact us.

F.5. Level of Care

In performing our services, we used that degree of care and skill ordinarily exercised under similar circumstances by reputable members of our profession currently practicing in the same locality. No warranty, express or implied, is made.

Appendix



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INFRASTRUCTURE ■ ENGINEERING ■ PLANNING ■ CONSTRUCTION

PROPOSED BORING LOCATIONS
MONTICELLO BUSINESS CENTER
CITY OF MONTICELLO

WSB Project No. 01488-92 June 26, 2006
CITYPROJNO

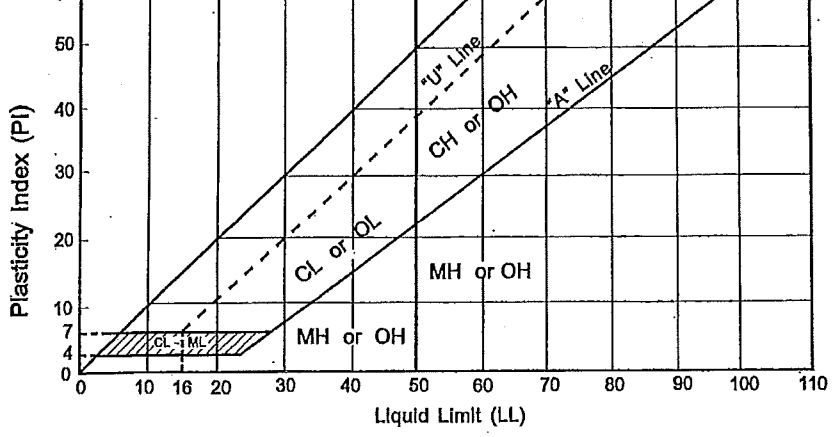
Figure Number
1

Descriptive Terminology

Standard D 2487 - 00
Classification of Soils for Engineering Purposes
(Unified Soil Classification System)

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [a]				Soils Classification	
				Group Symbol	Group Name [b]
Coarse-grained Soils more than 50% retained on No. 200 sieve	Gravels More than 50% of coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5% fines [e]	$C_u \geq 4$ and $1 \leq C_c \leq 3$ [c]	GW	Well-graded gravel [d]
			$C_u < 4$ and/or $1 > C_c > 3$ [c]	GP	Poorly graded gravel [d]
		Gravels with Fines More than 12% fines [e]	Fines classify as ML or MH	GM	Silty gravel [d f g]
			Fines classify as CL or CH	GC	Clayey gravel [d f g]
	Sands 50% or more of coarse fraction passes No. 4 sieve	Clean Sands Less than 5% fines [i]	$C_u \geq 6$ and $1 \leq C_c \leq 3$ [c]	SW	Well-graded sand [h]
			$C_u < 6$ and/or $1 > C_c > 3$ [c]	SP	Poorly graded sand [h]
		Sands with Fines More than 12% [i]	Fines classify as ML or MH	SM	Silty sand [f g h]
			Fines classify as CL or CH	SC	Clayey sand [f g h]
Fine-grained Soils 50% or more passed the No. 200 sieve	Silts and Clays Liquid limit less than 50	Inorganic	PI > 7 and plots on or above "A" line [j]	CL	Lean clay [k l m]
			PI < 4 or plots below "A" line [j]	ML	Silt [k l m]
		Organic	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OL	Organic clay [k l m n]
				OL	Organic silt [k l m o]
	Silts and clays Liquid limit 50 or more	Inorganic	PI plots on or above "A" line	CH	Fat clay [k l m]
			PI plots below "A" line	MH	Elastic silt [k l m]
		Organic	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OH	Organic clay [k l m p]
				OH	Organic silt [k l m q]
Highly Organic Soils		Primarily organic matter, dark in color and organic odor		PT	Peat

a. Based on the material passing the 3-in (75mm) sieve.
b. If field sample contained cobbles or boulders, or both, add "with cobbles or boulders or both" to group name.
c. $C_u = D_{60} / D_{10}$ $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$
d. If soil contains ≥15% sand, add "with sand" to group name.
e. Gravels with 5 to 12% fines require dual symbols:
GW-GM well-graded gravel with silt
GW-GC well-graded gravel with clay
GP-GM poorly-graded gravel with silt
GP-GC poorly graded gravel with clay
f. If fines classify as CL-ML, use dual symbol GC-GM or SC-SM.
g. If fines are organic, add "with organic fines" to group name.
h. If soil contains ≥15% gravel, add "with gravel" to group name.
i. Sands with 5 to 12% fines require dual symbols:
SW-SM well-graded sand with silt
SW-SC well-graded sand with clay
SP-SM poorly graded sand with silt
SP-SC poorly graded sand with clay
j. If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay.
k. If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel" whichever is predominant.
l. If soil contains ≥ 30% plus No. 200, predominantly sand, add "sandy" to group name.
m. If soil contains ≥ 30% plus No. 200 predominantly gravel, add "gravelly" to group name.
n. PI ≥ 4 and plots on or above "A" line.
o. PI < 4 or plots below "A" line.
p. PI plots on or above "A" line.
q. PI plots below "A" line.



Laboratory Tests

DD	Dry density, pcf	OC	Organic content, %
WD	Wet density, pcf	S	Percent of saturation, %
MC	Natural moisture content, %	SG	Specific gravity
LL	Liquid limit, %	C	Cohesion, psf
PL	Plastic limit, %	∅	Angle of internal friction
PI	Plasticity index, %	qu	Unconfined compressive strength, psf
P2000	% passing 200 sieve	qp	Pocket penetrometer strength, tsf

Particle Size Identification

Boulders	over 12"
Cobbles	3" to 12"
Gravel	
Coarse	3/4" to 3"
Fine	No. 4 to 3/4"
Sand	
Coarse	No. 4 to No. 10
Medium	No. 10 to No. 40
Fine	No. 40 to No. 200
Silt	<No. 200, PI< 4 or below "A" line
Clay	<No. 200, PI≥ 4 and on or above "A" line

Relative Density of Cohesionless Soils

Very loose	0 to 4 BPF
Loose	5 to 10 BPF
Medium dense	11 to 30 BPF
Dense	31 to 50 BPF
Very dense	over 50 BPF

Consistency of Cohesive Soils

Very soft	0 to 1 BPF
Soft	2 to 3 BPF
Rather soft	4 to 5 BPF
Medium	6 to 8 BPF
Rather stiff	9 to 12 BPF
Stiff	13 to 16 BPF
Very stiff	17 to 30 BPF
Hard	over 30 BPF

Drilling Notes

Standard penetration test borings were advanced by 3□" or 6□" ID hollow-stem augers unless noted otherwise, Jetting water was used to clean out auger prior to sampling only where indicated on logs. Standard penetration test borings are designated by the prefix "ST" (Split Tube). All samples were taken with the standard 2" OD split-tube sampler, except where noted.

Power auger borings were advanced by 4" or 6" diameter continuous-flight, solid-stem augers. Soil classifications and strata depths were inferred from disturbed samples augered to the surface and are, therefore, somewhat approximate. Power auger borings are designated by the prefix "B."

Hand auger borings were advanced manually with a 1" or 3□" diameter auger and were limited to the depth from which the auger could be manually withdrawn. Hand auger borings are indicated by the prefix "H."

BPF: Numbers indicate blows per foot recorded in standard penetration test, also known as "N" value. The sampler was set 6" into undisturbed soil below the hollow-stem auger. Driving resistances were then counted for second and third 6" increments and added to get BPF. Where they differed significantly, they are reported in the following form: 2/12 for the second and third 6" increments, respectively.

WH: WH indicates the sampler penetrated soil under weight of hammer and rods alone; driving not required.

WR: WR indicates the sampler penetrated soil under weight of rods alone; hammer weight and driving not required.

TW indicates thin-walled (undisturbed) tube sample.

Note: All tests were run in general accordance with applicable ASTM standards.

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LOG OF BORING

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BORING: **1**

LOCATION: See sketch.

DRILLER: M. Belch | METHOD: 3 1/4" HSA, Autohmr. | DATE: 7/11/06 | SCALE: 1" = 4'

Elev. feet	Depth feet	ASTM Symbol	Description of Materials (ASTM D2488 or D2487)	BPF	WL	Tests or Notes
936.6	0.0	SP	POORLY GRADED SAND, fine- to coarse-grained, with GRAVEL, brown, moist to waterbearing, loose to medium dense to very loose. (Glacial Outwash)	9 7 14 11		Elevations at the borings were provided by WSB.
				4 5	▽	The triangle in the WL column indicates the highest level at which groundwater was observed while drilling. Groundwater levels fluctuate. Please refer to the discussions in Sections B.4. and F.3. of our report.
921.1	15.5		END OF BORING Water observed at 12 feet while drilling. Water down 14 feet with 14 feet of hollow-stem auger in the hole. Water not observed to cave-in depth of 13 feet immediately after withdrawal of auger. Boring then backfilled.			

(See Descriptive Terminology sheet for explanation of abbreviations)

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LOG OF BORING

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BORING: 2

LOCATION: See sketch.

DRILLER: M. Belch | METHOD: 3 1/4" HSA, Autohmr. | DATE: 7/11/06 | SCALE: 1" = 4'

Elev. feet	Depth feet	ASTM Symbol	Description of Materials (ASTM D2488 or D2487)	BPF	WL	Tests or Notes
947.1	0.0					
946.5	0.6	TS	SILTY SAND, fine-grained, dark brown, moist. (Topsoil)			
		SP	POORLY GRADED SAND, fine- to medium-grained, with GRAVEL, brown, moist, medium dense to loose. (Glacial Outwash)	20		
				12		
				11		
				5		
936.1	11.0					
		SP	POORLY GRADED SAND, fine-grained, brown, moist, loose. (Glacial Outwash)	7		
933.1	14.0					
		SP	POORLY GRADED SAND, fine- to medium-grained, with GRAVEL, brown, moist, medium dense to loose. (Glacial Outwash)	11		
926.6	20.5			9		
			END OF BORING Water not observed while drilling. Water not observed with 19 feet of hollow-stem auger in the hole. Water not observed to cave-in depth of 17 feet immediately after withdrawal of auger. Boring then backfilled.			

(See Descriptive Terminology sheet for explanation of abbreviations)

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BORING: 3

LOCATION: See sketch.

DRILLER: M. Belch | METHOD: 3 1/4" HSA, Autohmr. | DATE: 7/11/06 | SCALE: 1" = 4'

Elev. feet	Depth feet	ASTM Symbol	Description of Materials (ASTM D2488 or D2487)	BPF	WL	Tests or Notes
934.6	0.0					
933.4	1.2	TS	SILTY SAND, fine-grained, black, moist. (Topsoil)			
		SP	POORLY GRADED SAND, fine- to medium-grained, with GRAVEL, brown, moist to waterbearing, loose. (Glacial Outwash)	7		
				8		
				10		
				8		
				9	▽	
919.1	15.5			7		
			END OF BORING			

Water observed at 12 feet while drilling.

Water down 13 1/2 feet with 14 feet of hollow-stem auger in the hole.

Water not observed to cave-in depth of 10 1/2 feet immediately after withdrawal of auger.

Boring then backfilled.

(See Descriptive Terminology sheet for explanation of abbreviations)

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LOG OF BORING

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BORING: **4A**

LOCATION: 30'S of staked location due to overhead power lines. See sketch.

DRILLER: M. Belch | METHOD: 3 1/4" HSA, Autohmr. | DATE: 7/11/06 | SCALE: 1" = 4'

Elev. feet	Depth feet	ASTM Symbol	Description of Materials (ASTM D2488 or D2487)	BPF	WL	Tests or Notes
935.1	0.0					
934.1	1.0	SP-SM	POORLY GRADED SAND, fine- to medium-grained, with SILT, brown, moist. (Glacial Outwash)			
		SP	POORLY GRADED SAND, fine- to medium-grained, with GRAVEL, brown, moist, loose. (Glacial Outwash)	8		
				5		
				11		
926.1	9.0				▽	
		SP	POORLY GRADED SAND, medium- to coarse-grained, with GRAVEL, brown, waterbearing, medium dense. (Glacial Outwash)	11		
923.1	12.0					
		SP	POORLY GRADED SAND, fine- to medium-grained, with GRAVEL, brown, waterbearing, loose to very loose. (Glacial Outwash)	9		
919.6	15.5			4		
			END OF BORING Water observed at 9 feet while drilling. Water down 13 feet with 14 feet of hollow-stem auger in the hole. Water not observed to cave-in depth of 8 1/2 feet immediately after withdrawal of auger. Boring then backfilled.			

(See Descriptive Terminology sheet for explanation of abbreviations)

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BORING: 5

LOCATION: See sketch.

DRILLER: M. Belch | METHOD: 3 1/4" HSA, Autohmr. | DATE: 7/11/06 | SCALE: 1" = 4'

Elev. feet	Depth feet	ASTM Symbol	Description of Materials (ASTM D2488 or D2487)	BPF	WL	Tests or Notes
943.6	0.0					
943.1	0.5	TS	SILTY SAND, fine-grained, dark brown, moist. (Topsoil)			
		SP	POORLY GRADED SAND, fine- to medium-grained, with GRAVEL, brown, moist, loose to medium dense. (Glacial Outwash)	9		
				17		
				18		
				10		
				9		
				11		
					▽	
923.1	20.5			9		
			END OF BORING			
			Water observed at 18 feet while drilling.			
			Water down 18 feet with 19 feet of hollow-stem auger in the hole.			
			Water not observed to cave-in depth of 16 1/2 feet immediately after withdrawal of auger.			
			Boring then backfilled.			

(See Descriptive Terminology sheet for explanation of abbreviations)

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BORING: 6

LOCATION: See sketch.

DRILLER: M. Belch | METHOD: 3 1/4" HSA, Autohmr. | DATE: 7/11/06 | SCALE: 1" = 4'

Elev. feet	Depth feet	ASTM Symbol	Description of Materials (ASTM D2488 or D2487)	BPF	WL	Tests or Notes
936.7	0.0	TS	SILTY SAND, fine-grained, black, moist. (Topsoil)			
934.2	2.5	SM	SILTY SAND, fine-grained, dark brown, moist, loose. (Alluvium)	7		
932.7	4.0	SP	POORLY GRADED SAND, fine- to medium-grained, with GRAVEL, brown, moist, loose. (Glacial Outwash)	6		
929.7	7.0	SP	POORLY GRADED SAND, fine-grained, brown, moist, loose. (Glacial Outwash)	7		
927.7	9.0	SP	POORLY GRADED SAND, fine- to medium-grained, with GRAVEL, brown, moist to waterbearing, loose to very loose. (Glacial Outwash)	5		
				6	▽	
				4		
916.2	20.5			6		
			END OF BORING Water observed at 12 feet while drilling. Water down 18 feet with 19 feet of hollow-stem auger in the hole. Water not observed to cave-in depth of 11 feet immediately after withdrawal of auger. Boring then backfilled.			

(See Descriptive Terminology sheet for explanation of abbreviations)

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BORING: 7

LOCATION: See sketch.

DRILLER: M. Belch | METHOD: 3 1/4" HSA, Autohmr. | DATE: 7/11/06 | SCALE: 1" = 4'

Elev. feet	Depth feet	ASTM Symbol	Description of Materials (ASTM D2488 or D2487)	BPF	WL	Tests or Notes
946.1	0.0	FILL	FILL: Silty Sand, fine-grained, black and dark brown, moist.	8 5 4 3		
934.1	12.0	SP	POORLY GRADED SAND, fine-grained, trace Gravel, brown, moist, medium dense to loose. (Glacial Outwash)	13 10		
927.1	19.0	SP	POORLY GRADED SAND, fine- to coarse-grained, with GRAVEL, brown, waterbearing, medium dense. (Glacial Outwash)	11		
925.6	20.5		END OF BORING Water not observed while drilling. Water down 19 feet with 20 feet of hollow-stem auger in the ground. Water not observed to cave-in depth of 16 feet immediately after withdrawal of auger. Boring then backfilled.			

(See Descriptive Terminology sheet for explanation of abbreviations)

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BORING: **8**

LOCATION: See sketch.

DRILLER: M. Belch | METHOD: 3 1/4" HSA, Autohmr. | DATE: 7/10/06 | SCALE: 1" = 4'

Elev. feet	Depth feet	ASTM Symbol	Description of Materials (ASTM D2488 or D2487)	BPF	WL	Tests or Notes
942.1	0.0	FILL	FILL: Silty Sand, fine-grained, trace Gravel, black, moist.	9		
937.1	5.0	SP	POORLY GRADED SAND, fine- to medium-grained, with GRAVEL, brown, moist to waterbearing at 4 1/2 feet, medium dense to loose. (Glacial Outwash)	11		
				10		
				9		
				9		
926.6	15.5			7	▽	
			END OF BORING Water observed at 14 feet while drilling. Water down 14 feet with 14 feet of hollow-stem auger in the hole. Water not observed to cave-in depth of13 feet immediately after withdrawal of auger. Boring then backfilled.			

(See Descriptive Terminology sheet for explanation of abbreviations)

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BORING: 9

LOCATION: See sketch.

DRILLER: M. Belch | METHOD: 3 1/4" HSA, Autohmr. | DATE: 7/10/06 | SCALE: 1" = 4'

Elev. feet	Depth feet	ASTM Symbol	Description of Materials (ASTM D2488 or D2487)	BPF	WL	Tests or Notes
938.8	0.0	FILL	FILL: Silty Sand, fine-grained, dark brown, moist.			
936.8	2.0	FILL	FILL: Poorly Graded Sand, fine- to medium-grained, with Silt and Gravel, brown with dark brown, moist.	9		
933.8	5.0	SP	POORLY GRADED SAND, fine- to medium-grained, with GRAVEL, brown, moist to waterbearing at 12 feet, loose to very loose. (Glacial Outwash)	10		
				8		
				3		
				5	▽	
				5		
920.8	18.0	SP	POORLY GRADED SAND, fine-grained, brown, waterbearing, very loose. (Glacial Outwash)			
918.3	20.5			2		
			END OF BORING Water observed at 12 feet while drilling. Water down 17 1/2 feet with 19 feet of hollow-stem auger in the hole. Water not observed to cave-in depth of 12 feet immediately after withdrawal of auger. Boring then backfilled.			

(See Descriptive Terminology sheet for explanation of abbreviations)

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BORING: **10**

LOCATION: See sketch.

DRILLER: M. Belch | METHOD: 3 1/4" HSA, Autohmr. | DATE: **7/10/06** | SCALE: **1" = 4'**

Elev. feet	Depth feet	ASTM Symbol	Description of Materials (ASTM D2488 or D2487)	BPF	WL	Tests or Notes
948.7	0.0	TS	SILTY SAND, fine-grained, dark brown, moist. (Topsoil)			
946.2	2.5	SP	POORLY GRADED SAND, fine- to medium-grained, with GRAVEL, brown, moist, loose to medium dense. (Glacial Outwash)	17		
				10		
				8		
				7		
				7		
				11		
929.7	19.0				▽	
		SP	POORLY GRADED SAND, fine- to coarse-grained, with GRAVEL, brown, waterbearing, very loose to loose. (Glacial Outwash)	4		
923.2	25.5			6		
			END OF BORING Water observed at 19 feet while drilling. Water down 24 feet with 24 feet of hollow-stem auger in the hole. Water not observed to cave-in depth of 19 feet immediately after withdrawal of auger. Boring then backfilled.			

(See Descriptive Terminology sheet for explanation of abbreviations)

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BORING: 11

LOCATION: See sketch.

DRILLER: M. Belch | METHOD: 3 1/4" HSA, Autohmr. | DATE: 7/10/06 | SCALE: 1" = 4'

Elev. feet	Depth feet	ASTM Symbol	Description of Materials (ASTM D2488 or D2487)	BPF	WL	Tests or Notes
946.2	0.0					
945.9	0.3	TS	SILTY SAND, fine-grained, dark brown, moist. (Topsoil)			
		SP	POORLY GRADED SAND, fine-grained, trace Gravel, brown, moist, medium dense. (Glacial Outwash)	15		
				14		
940.2	6.0	SP	POORLY GRADED SAND, fine- to medium-grained, brown, moist, loose. (Glacial Outwash)	8		
936.2	10.0	SP	POORLY GRADED SAND, fine- to medium-grained, with GRAVEL, brown, moist, loose. (Glacial Outwash)	8		
				9		
			-lenses of black at 15 feet.	7		
					▽	
925.7	20.5			2		
			END OF BORING Water observed at 18 feet while drilling. Water down 18 feet with 19 feet of hollow-stem auger in the hole. Water not observed to cave-in depth of 17 feet immediately after withdrawal of auger. Boring then backfilled.			

(See Descriptive Terminology sheet for explanation of abbreviations)

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BORING: **12**

LOCATION: See sketch.

DRILLER: M. Belch | METHOD: 3 1/4" HSA, Autohmr. | DATE: 7/10/06 | SCALE: 1" = 4'

Elev. feet	Depth feet	ASTM Symbol	Description of Materials (ASTM D2488 or D2487)	BPF	WL	Tests or Notes
936.6	0.0	TS	SILTY SAND, fine-grained, dark brown, moist. (Topsoil)			
935.1	1.5	SP	POORLY GRADED SAND, fine- to medium-grained, with GRAVEL, brown, moist, very loose to loose. (Glacial Outwash)	4		
				9		
930.6	6.0	SP	POORLY GRADED SAND, fine- to coarse-grained, with GRAVEL, brown, moist to waterbearing, loose to very loose. (Glacial Outwash)	8	▽	
				4		
				7		
				9		
916.1	20.5			4		
			END OF BORING			
			Water observed at 9 feet while drilling.			
			Water down 14 1/2 feet with 19 feet of hollow-stem auger in the hole.			
			Water not observed to cave-in depth of 9 feet immediately after withdrawal of auger.			
			Boring then backfilled.			

(See Descriptive Terminology sheet for explanation of abbreviations)

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BORING: **13A**

LOCATION: 30'N of staked location because stake was on a scope. See sketch.

DRILLER: M. Belch | METHOD: 3 1/4" HSA, Autohmr. | DATE: 7/10/06 | SCALE: 1" = 4'

Elev. feet	Depth feet	ASTM Symbol	Description of Materials (ASTM D2488 or D2487)	BPF	WL	Tests or Notes
934.0	0.0	SP	POORLY GRADED SAND, fine-grained, brown, moist. (Glacial Outwash)			
932.0	2.0	SP-SM	POORLY GRADED SAND, fine- to medium-grained, with SILT and GRAVEL, brown, moist, medium dense. (Glacial Outwash)	22		
931.0	3.0	SP	POORLY GRADED SAND, fine-grained, brown, moist to waterbearing, medium dense to very loose. (Glacial Outwash)	16	▽	
				13		
				7		
				5		
				1		
915.0	19.0	SP	POORLY GRADED SAND, coarse-grained, with GRAVEL, brown, waterbearing, loose. (Glacial Outwash)	7		
910.0	24.0	SM	SILTY SAND, fine- to medium-grained, with GRAVEL, brown, moist, medium dense. (Glacial Till)	22		
908.5	25.5		END OF BORING			
			Water observed at 7 feet while drilling.			
			Water down 23 feet with 24 feet of hollow-stem auger in the hole.			
			Water not observed to cave-in depth of 5 1/2 feet immediately after withdrawal of auger.			
			Boring then backfilled.			

(See Descriptive Terminology sheet for explanation of abbreviations)

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BORING: 14

LOCATION: See sketch.

DRILLER: M. Belch | METHOD: 3 1/4" HSA, Autohmr. | DATE: 7/16/06 | SCALE: 1" = 4'

Elev. feet	Depth feet	ASTM Symbol	Description of Materials (ASTM D2488 or D2487)	BPF	WL	Tests or Notes
934.2	0.0	SP	POORLY GRADED SAND, fine-grained, trace Gravel, brown, moist, loose. (Glacial Outwash)	10		
930.2	4.0	SP	POORLY GRADED SAND, fine- to medium-grained, with GRAVEL, brown, waterbearing, loose to very loose. (Glacial Outwash)	7	▽	
				6		
				3		
				9		
918.7	15.5			6		
			END OF BORING Water observed at 4 feet while drilling. Water down 13 feet with 14 feet of hollow-stem auger in the hole. Boring then backfilled.			

(See Descriptive Terminology sheet for explanation of abbreviations)

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BORING: 15

LOCATION: See sketch.

DRILLER: M. Belch | METHOD: 3 1/4" HSA, Autohmr. | DATE: 7/10/06 | SCALE: 1" = 4'

Elev. feet	Depth feet	ASTM Symbol	Description of Materials (ASTM D2488 or D2487)	BPF	WL	Tests or Notes
946.6	0.0					
945.5	1.1	TS	SILTY SAND, fine-grained, dark brown, moist. (Topsoil)			
		SP	POORLY GRADED SAND, fine-grained, trace Gravel, brown, moist, loose. (Glacial Outwash)	9		
942.6	4.0	SP	POORLY GRADED SAND, fine- to medium-grained, with GRAVEL, brown, moist, loose to medium dense. (Glacial Outwash)	8		
				15		
				10		
				11		
931.1	15.5			13		
			END OF BORING			
			Water not observed while drilling.			
			Water not observed with 14 feet of hollow-stem auger in the hole.			
			Water not observed to cave-in depth of 10 feet immediately after withdrawal of auger.			
			Boring then backfilled.			

(See Descriptive Terminology sheet for explanation of abbreviations)

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